Use of physicochemical characteristics of some selected binary fat blends to predict physicochemical properties of correspondent ternary fat blends.

gembloux
faculté universitaire
des sciences agronomiques

Sabine DANTHINE and Claude DEROANNE

Gembloux Agricultural University
Food Technology Department
Belgium

http//www.fsagx.ac.be/ta

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Physicochemical properties of some fat blends

- Introduction
- Binary blends
  - SFC profiles
  - Textural properties
- Ternary blends
  - SFC profiles
  - Textural properties
- Summary

Introduction

- What are lipid shortenings?
- My Ph-D thesis
- This lecture

Objectives

Study physical characteristics

- of single fats
- of a series of **binary blends**,

in order to

– determine the kind of molecular interactions involved

– predict physical properties of corresponding **ternary blends**

Material

- LERO : low erucic rapeseed oil
- HLERO : partially hydrogenated low erucic rapeseed oil
- PO : palm oil
- Pst : palm oil stearin
- Pol : palm oil olein
- HPO : partially hydrogenated palm oil
- SO : soybean oil
- HSO : partially hydrogenated soybean oil
- AMF : anhydrous milk fat

Binary blends : SFC

- Sample pre-conditioning:

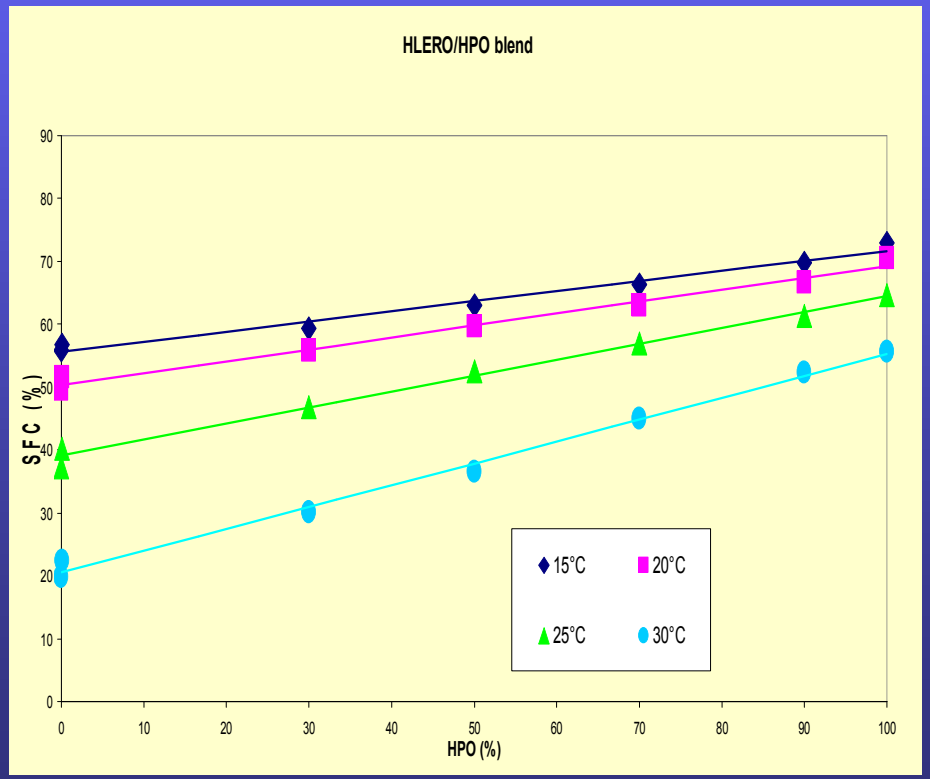
  Statical crystallization from the melt and storage at 15.0±0.5°C for 48 hours.

- Representations:
  - SFC at different temperatures versus blend compositions.
  - Corresponding SFC isosolid lines (temperature versus blend compositions).

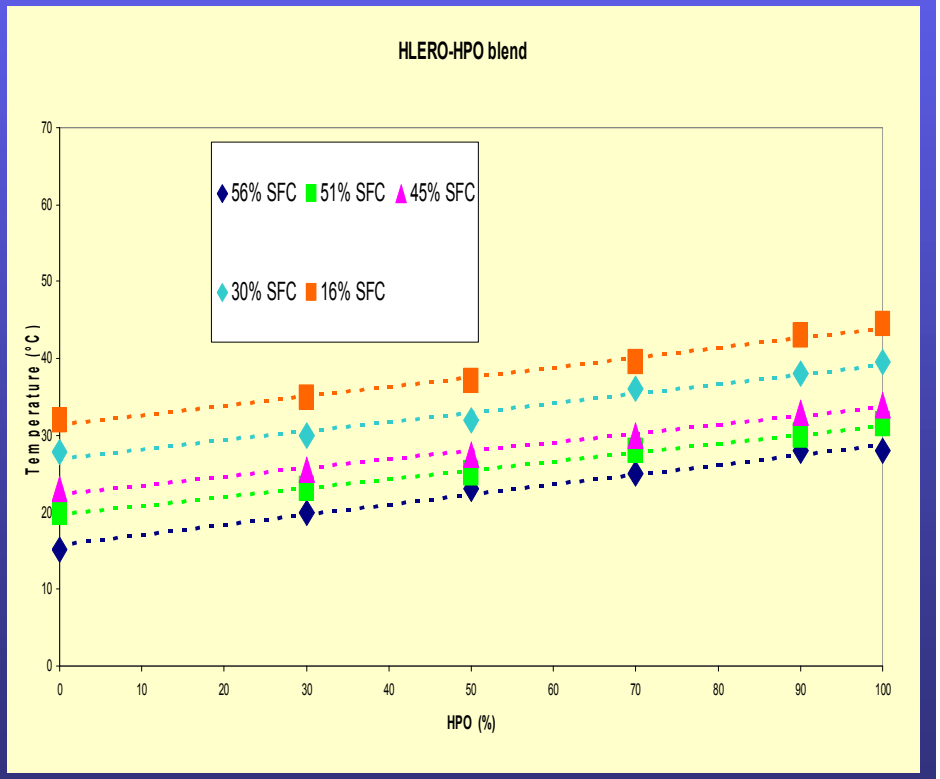
Binary blends : SFC

HPO/HLERO - Ideal behavior - Linear interpolation :

SFC versus blend compositions:



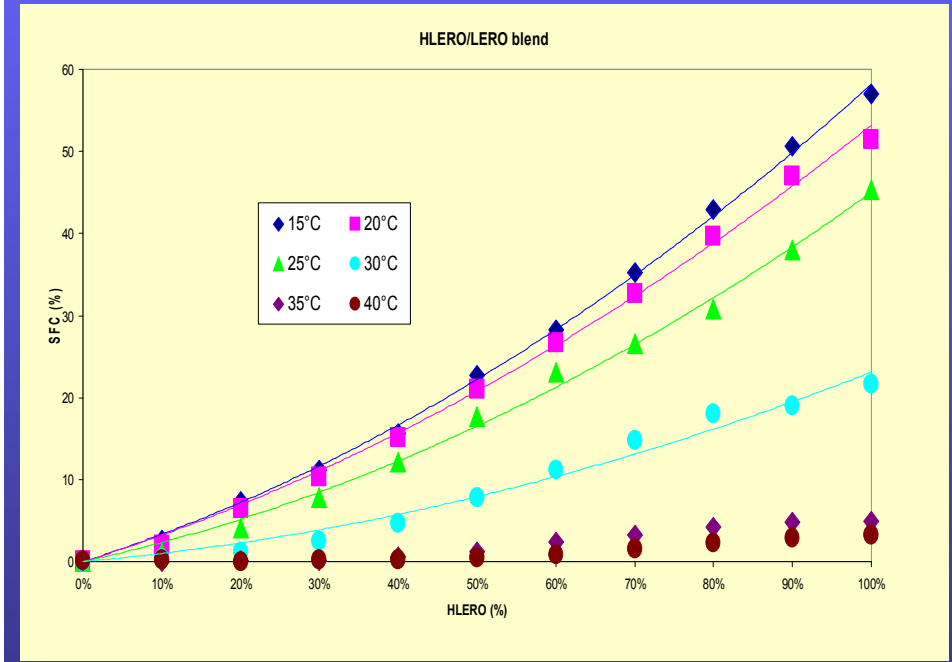
Iso-solid lines:



Binary blends : SFC

LERO/HLERO : Non-Ideal behavior - monotectic interaction :

SFC versus blend compositions:



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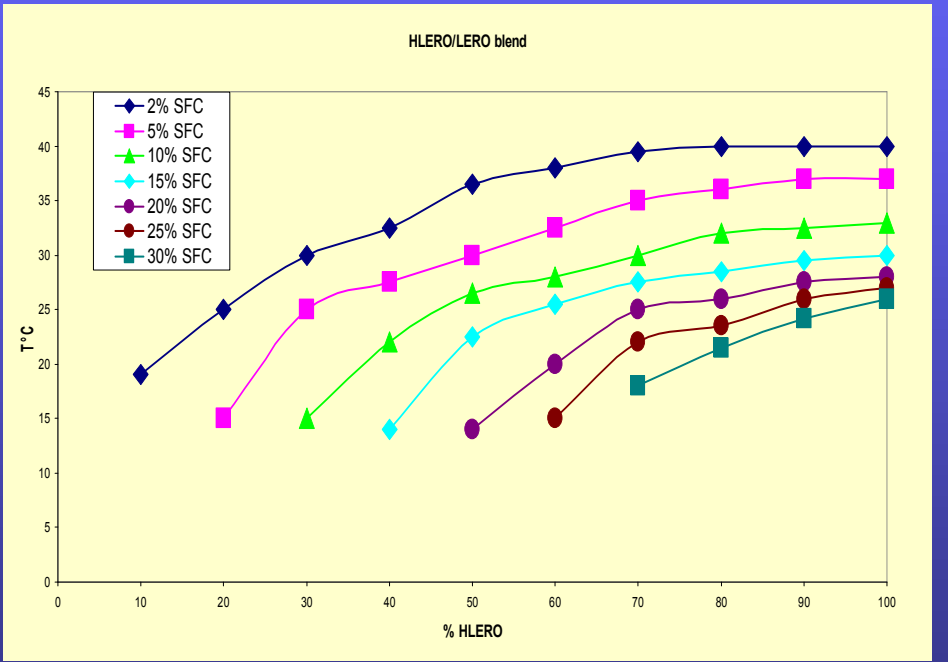


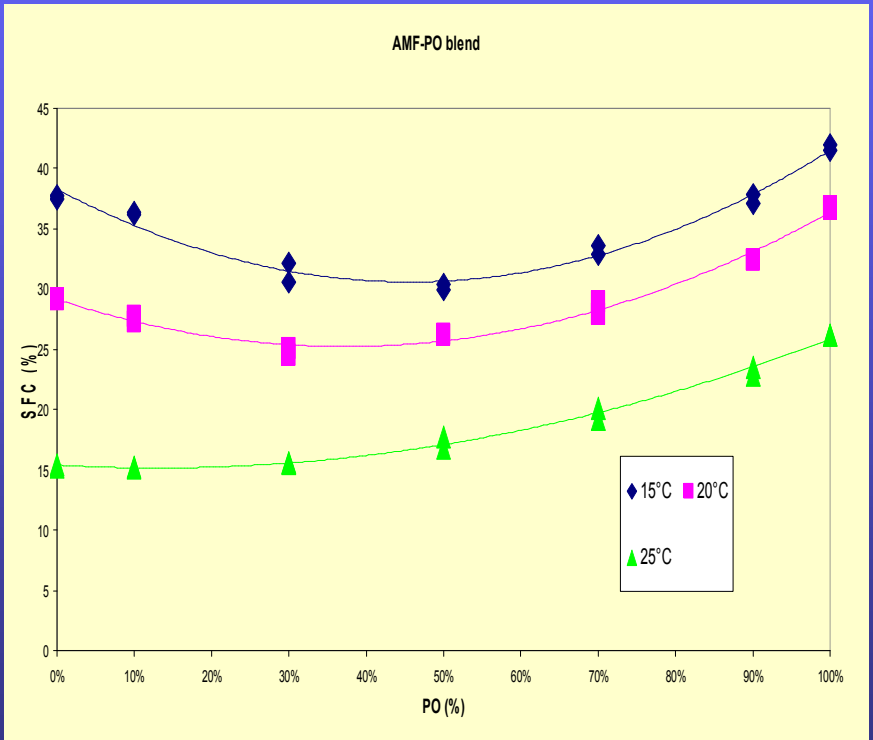
2^d order polynomial relationship :

$$SFC_{LERO/HLERO} = a[HLERO]^2 + b[HLERO]$$

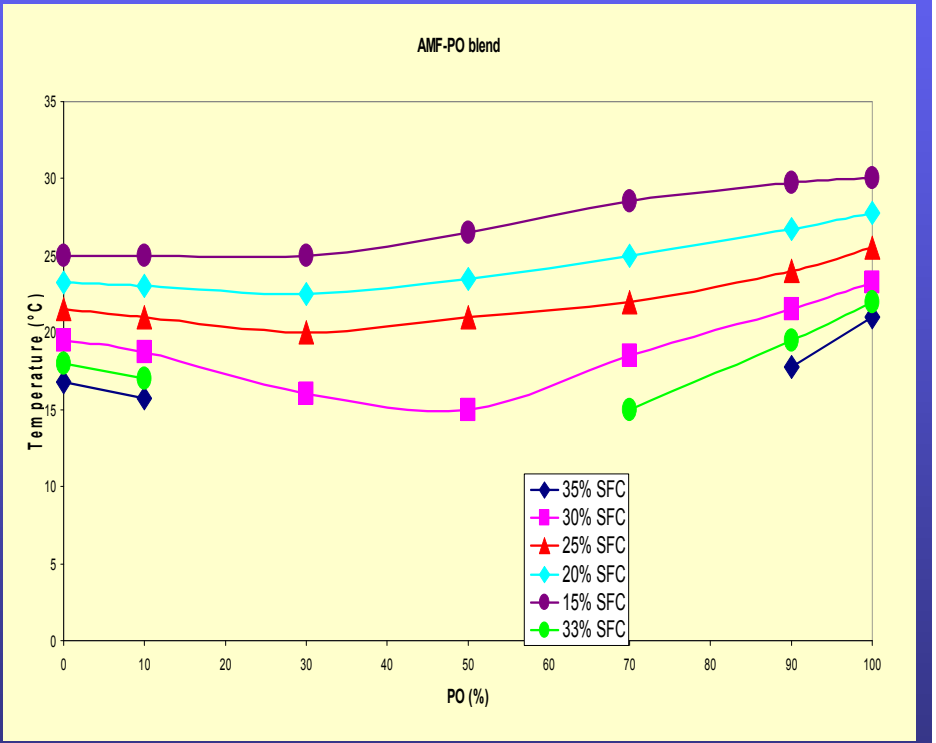
Binary blends : SFC

PO/AMF - Non-Ideal behavior - Eutectic interaction :

SFC versus blend compositions:



Iso-solid lines:



2^{d} order polynomial relationship :

$$SFC_{PO/AMF} = a[PO]^2 + b[PO] + SFC_{(AMF)}$$

Binary blends : Texture/SFC

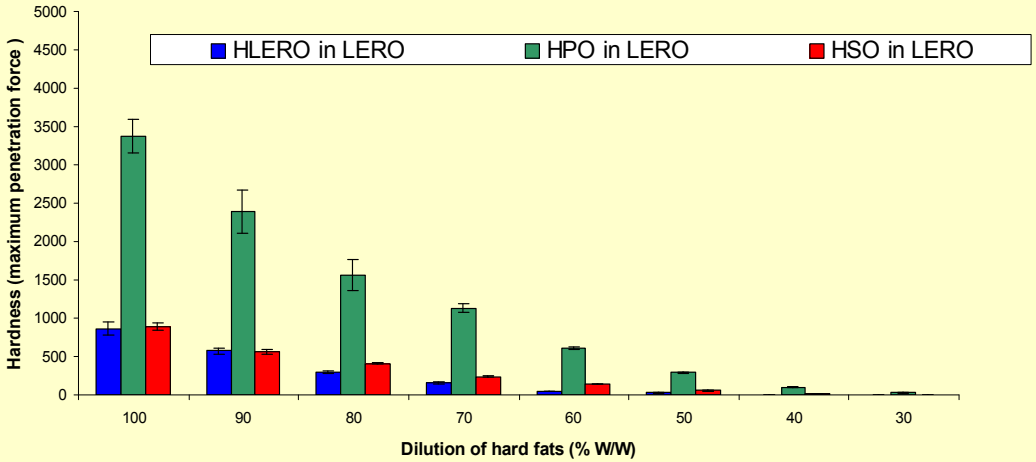
- Samples:
  - Statically crystallized from the melt
  - Stored at 15.0±0.5°C for 16, 24 or 48 hours.
  - Held 1 hour at 20±0.1°C before analysis

- Measurements:
  - Constant speed penetration tests
  - Texturometer with a cone probe (P/45C) in a controlled temperature room (20±0.1°C)
  - Isothermal SFC at 20°C

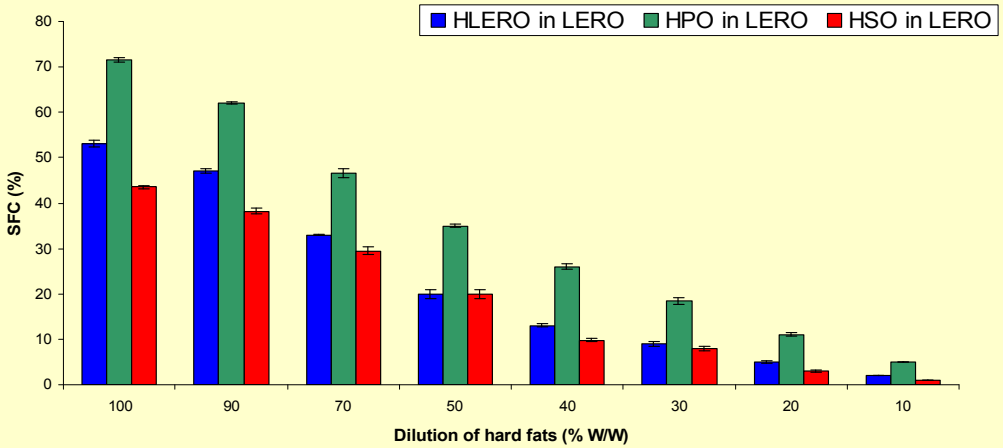
Binary blends : Texture/SFC

HLERO/HPO/HSO in LERO

Hardness



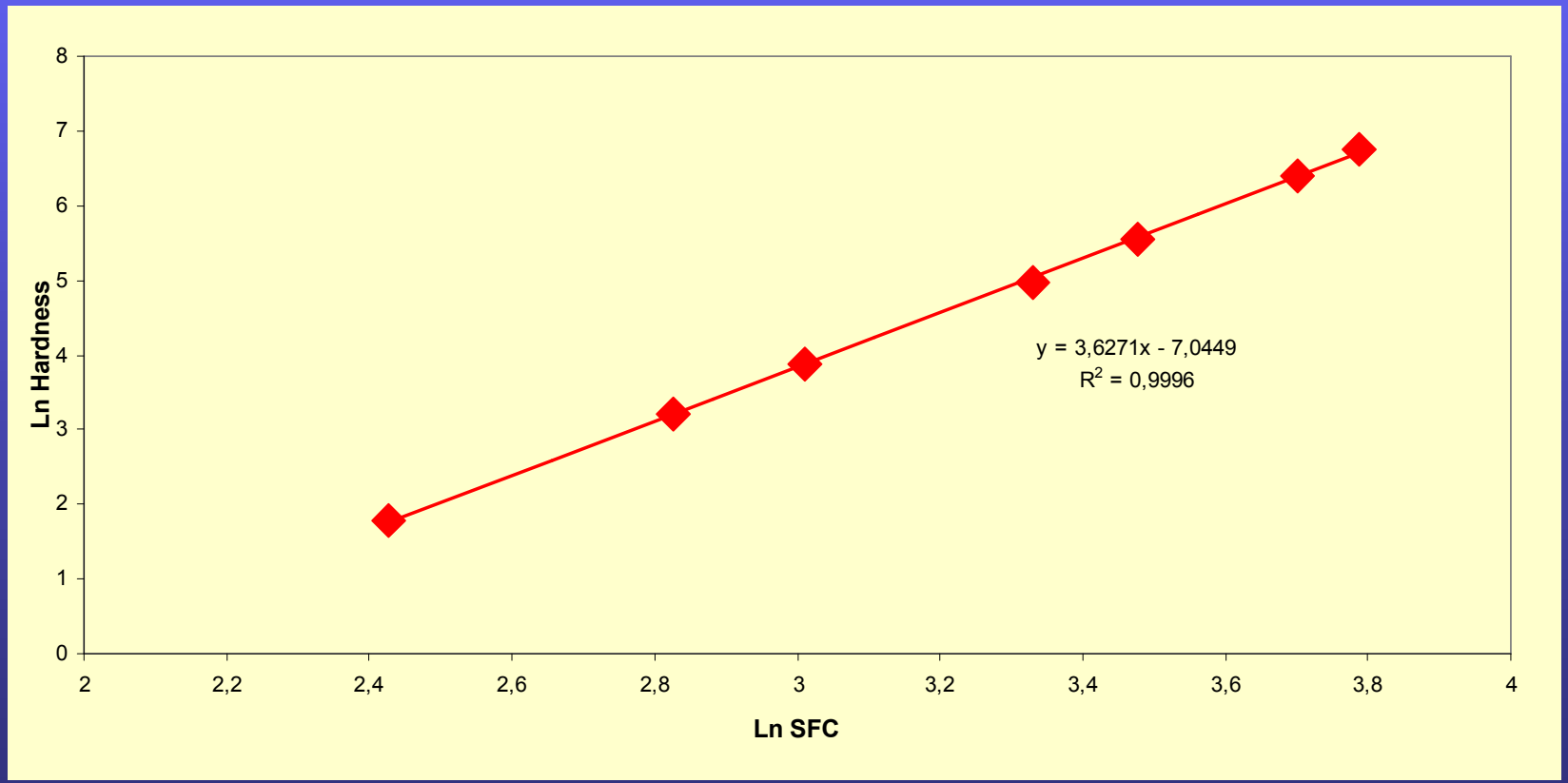
SFC



(Braipson-Danthine S., Deroanne C., Food Research International, 2004)

Binary blends : Texture/SFC

HLERO/LERO blend :

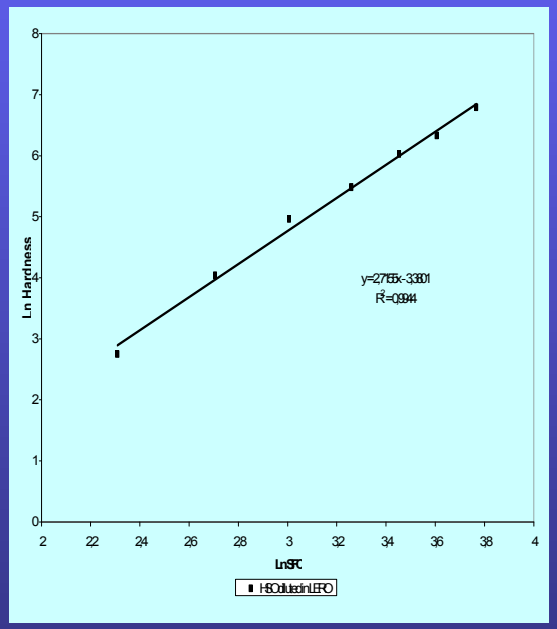


(Braipson-Danthine S., Deroanne C., Food Research International, 2004)

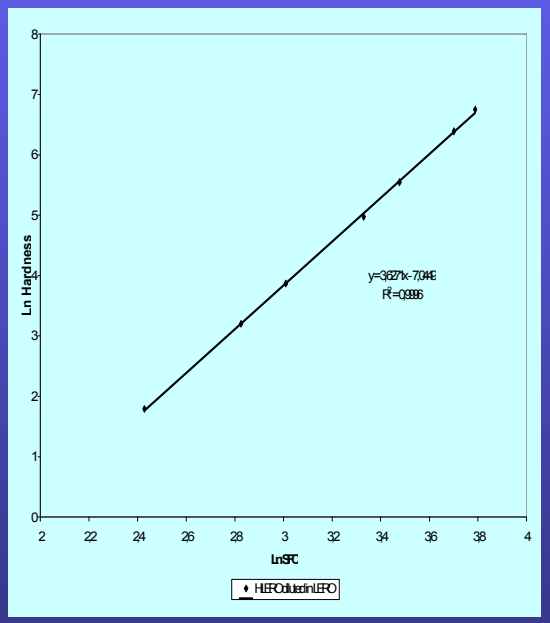
Binary blends : Texture/SFC

(Braipson-Danthine S., Deroanne C., Food Research International, 2004)

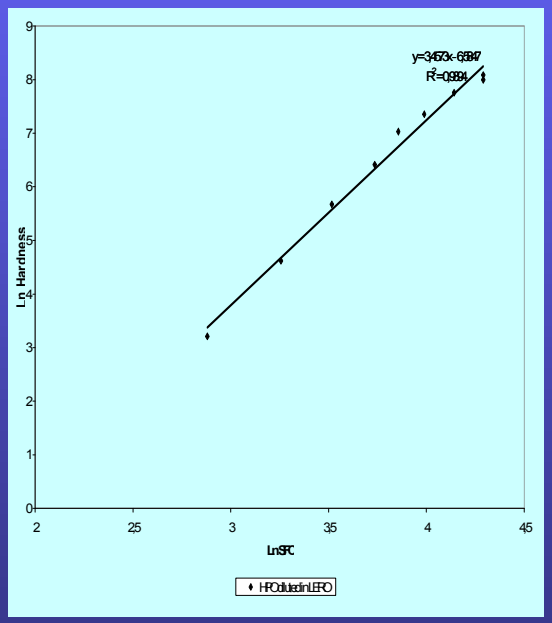
HSO/LERO



HLERO/LERO



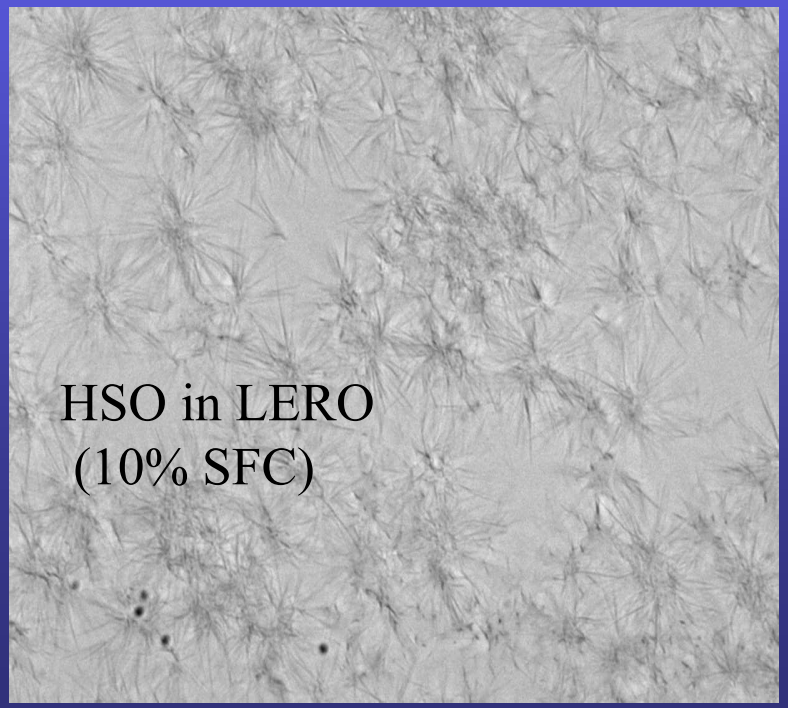
HPO/LERO

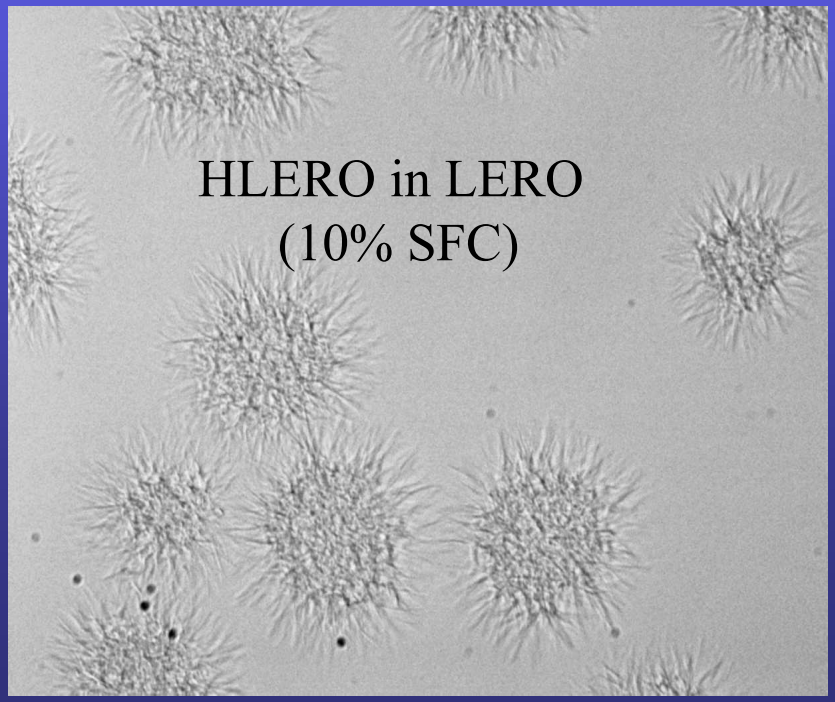


The slopes of the relationships are characteristic of the blends

Binary blends : Texture/SFC

The slopes of the relationships are characteristic of the blends and related to the microstructure of the samples (pictures at 20°C).





(Braipson-Danthine S., Deroanne C., Food Research International, 2004)

Ternary blends : SFC

- Samples preparation: like binary blends
- Aim : predict SFC of a ternary blend from data obtained for binary blends

Ternary blends : SFC

- Regression equations for the binary blends:
  - Linear for ideal behavior
  - Polynomial type in case of incompatibility.

- Combination of these equations

Calculation of SFC for the ternary blends,
Comparison with actual SFC,
Comparison with SFC of an « ideal blend ».

Ternary blends : SFC

« Ideal blend » :

$$SFC_{t\ (TB : X/Y/Z)} = x\ SFC_X + y\ SFC_Y + z\ SFC_Z / (x+y+z)$$

where : x, y, z are the mass ratios of the 3 fats coded X, Y and Z.

Ternary blends : SFC

« Non-Ideal blend » : Ex. HLERO-LERO-HPO:

$$SFC_t\,(HPO/LERO) = a\,[HPO]^2 + b\,[HPO]$$

$$SFC_t\,(HLERO/LERO) = c\,[HLERO]^2 + d\,[HLERO]$$

$$SFC_t\,(HPO/HLERO) = e\,[HPO] + f$$

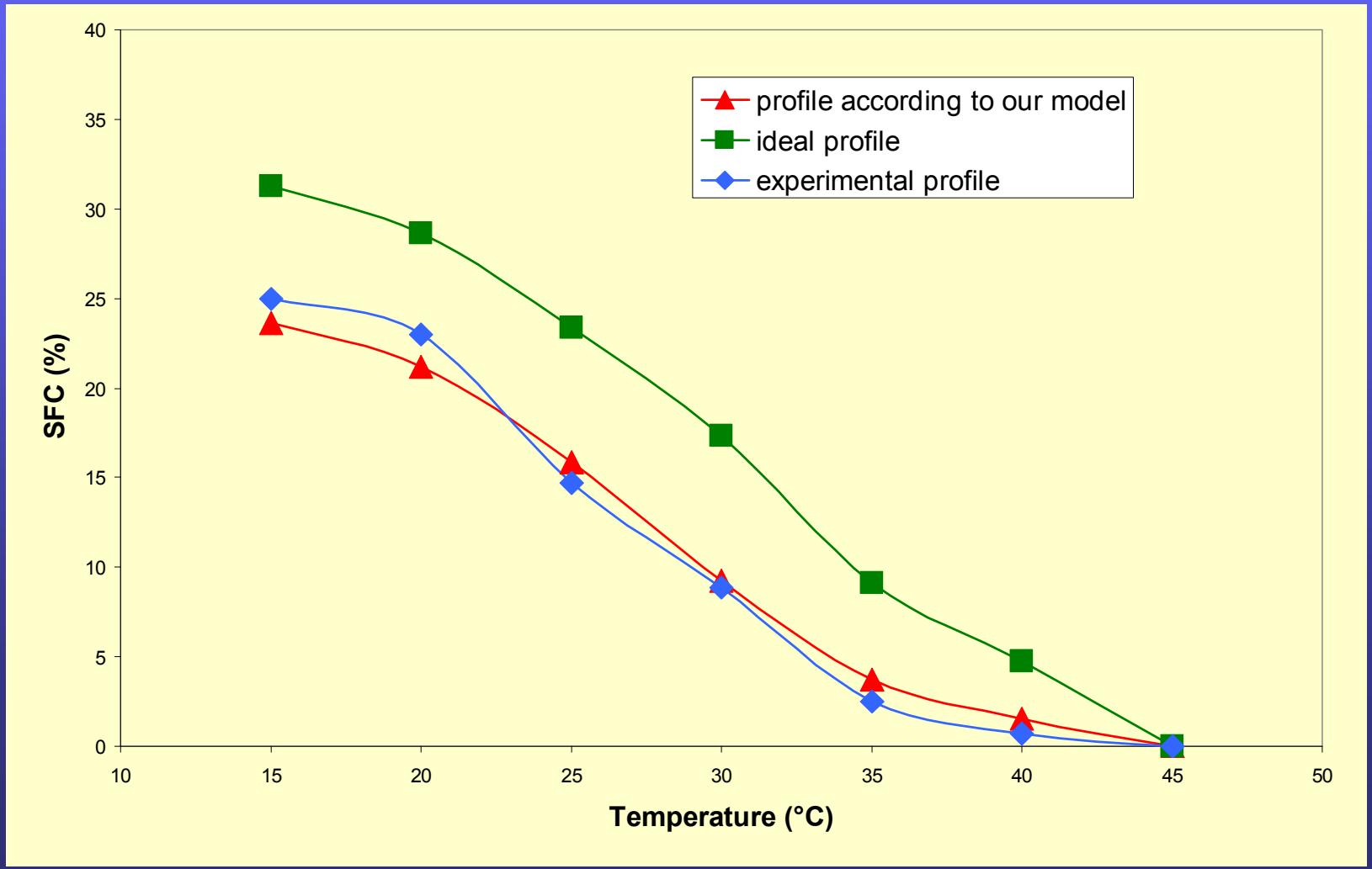
Where - [fat] is the concentration of the fat in the blend.
- f is the SFC of HLERO for the temperature t
- a, b, c, d and e are dependent on temperature

$$SFC_t\,(TB) = a\,[HPO]^2 + b\,[HPO] + c\,[HLERO]^2 + d\,[HLERO]$$

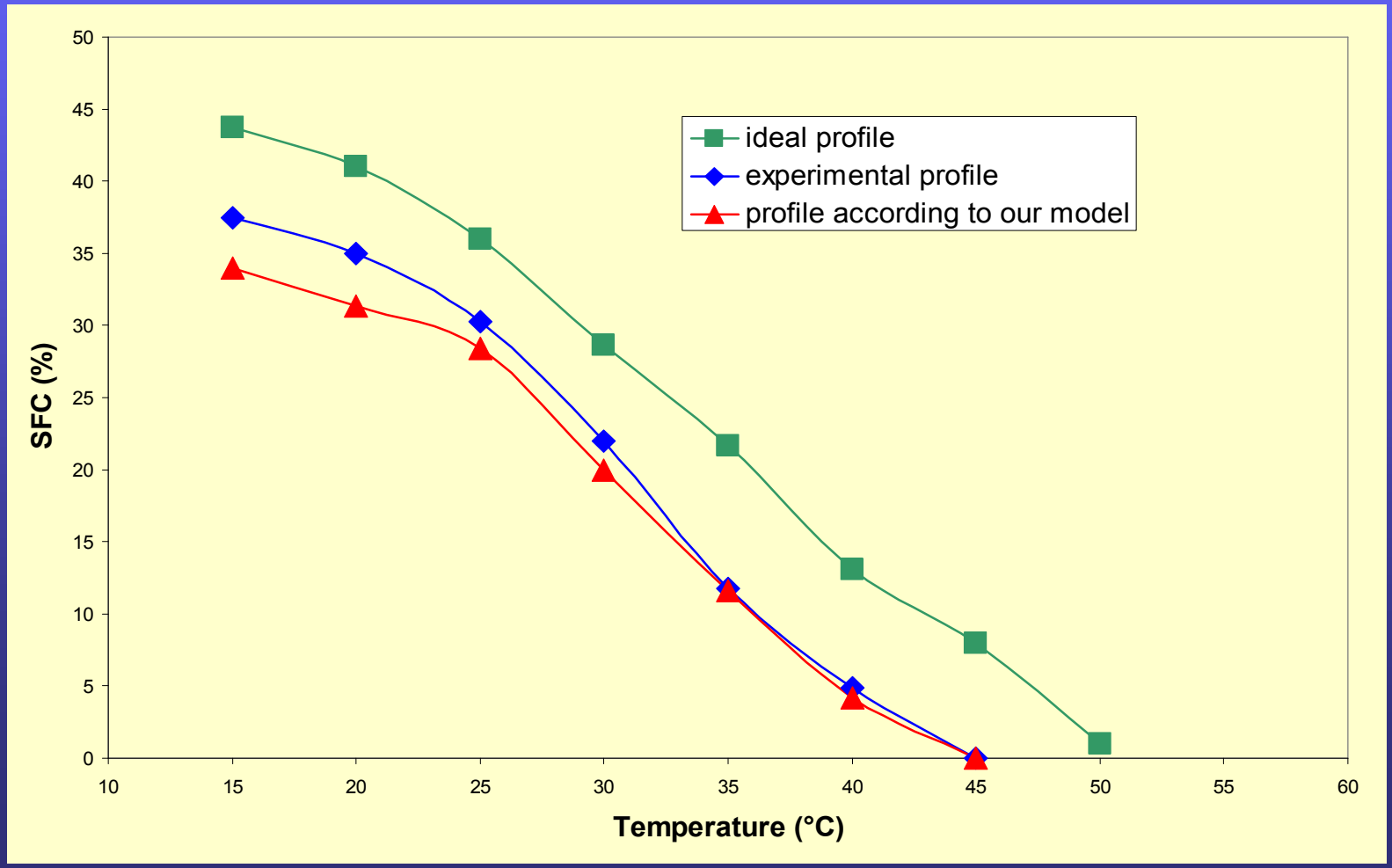
HLERO/HPO/LERO : SFC (15°C)

Composition HLERO/HPO/LERO (% / % / %)	SFC (%) of an « ideal blend » (A)	SFC (%) calculated according to our method (B)	SFC (%) Experimental values (C)	(C) – (A)	(C) – (B)
54/5/41	33.5	25.9	26.1	-7.4	0.2
50/5/45	31.3	23.6	24.9	-6.4	1.3
58/1/41	32.7	25.8	25.2	-7.5	-0.6
60/0/40	33	26.4	26.1	-6.9	-0.3
0/40/60	30.4	26.9	26.2	-4.2	-0.7
53.5/5/41.5	32.2	25.6	26	-6.2	0.4
33.3/33.3/33.3	43.7	34	37.5	-6.2	3.5
25/50/**25**	51.75	42.2	48.0	**-3.75**	**5.8**
50/25/**25**	46.5	36.9	41.5	**-5.0**	**4.6**
25/25/50	32.75	24.6	27.5	-5.25	2.9
20/20/60	26.2	19.3	21.9	-4.3	2.6
20/60/**20**	56.6	47.6	53.6	**-3.0**	**6.0**
60/20/**20**	48.2	39.5	44.8	**-3.4**	**5.3**

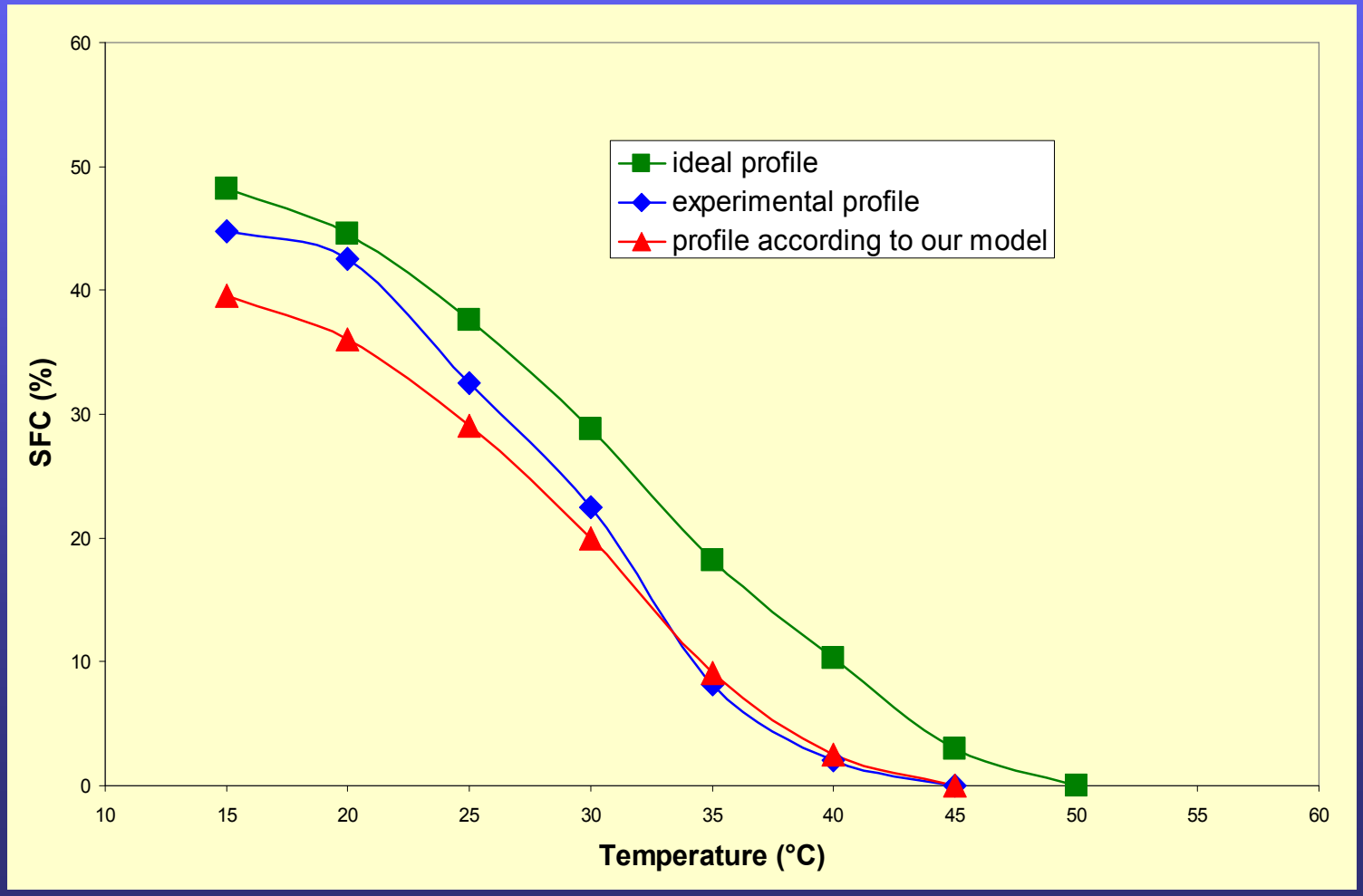
Ternary blends
HLERO 50% / HPO 5% / LERO 45% :
SFC profile



Ternary blends
HLERO 33.3% / HPO 33.3% / LERO 33.3%: SFC profile



Ternary blends
HLERO 60% / HPO 20% / LERO 20%:
SFC profile



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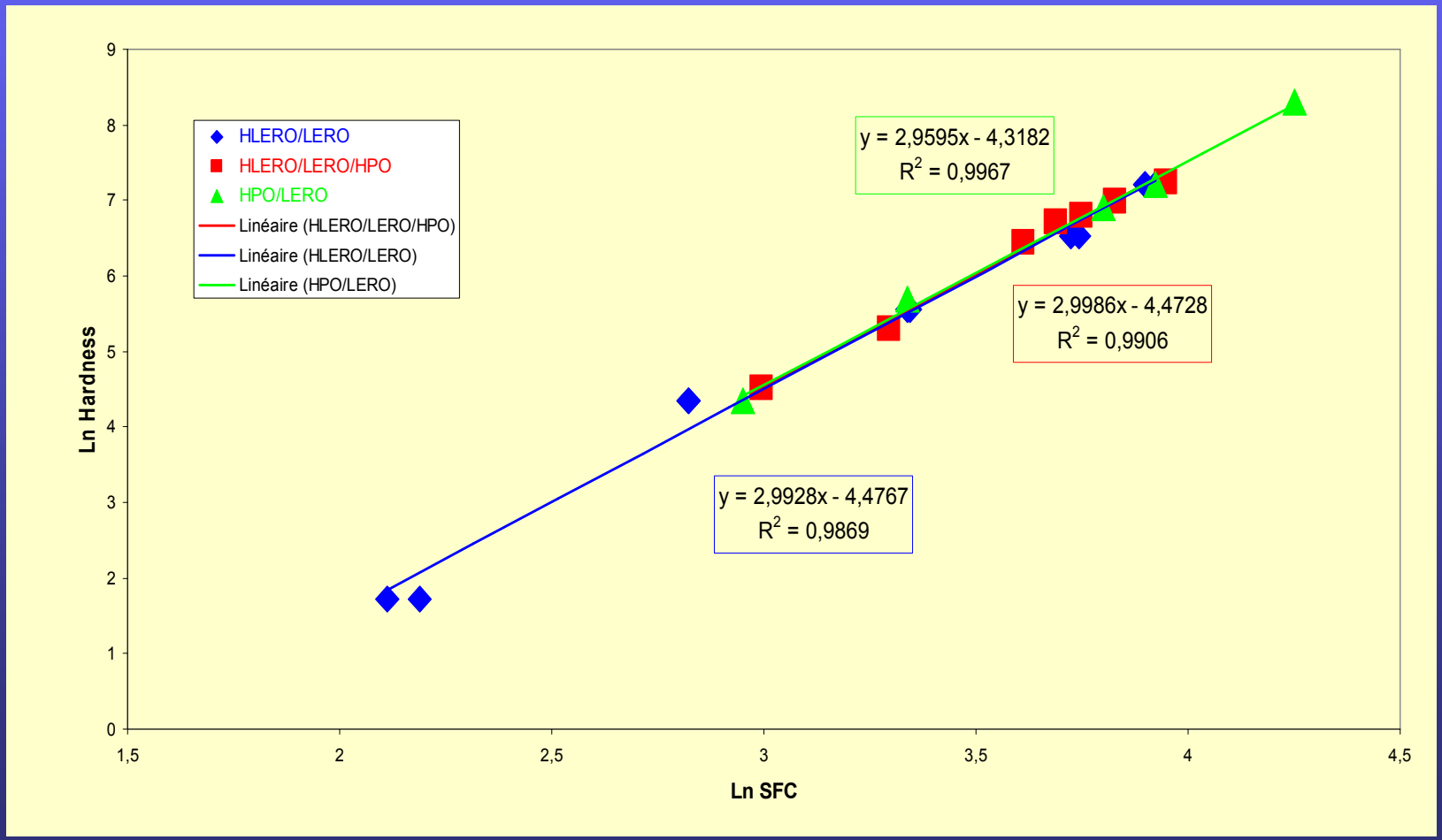
Ternary blends : texture/SFC
HLERO/HPO/LERO



Summary

- Binary blends : SFC + texture (hardness)

  SFC versus composition

  ln hardness versus ln SFC

- Ternary blends : SFC texture

Acknowledgements

- Organizing commitee
- AOCS foundation